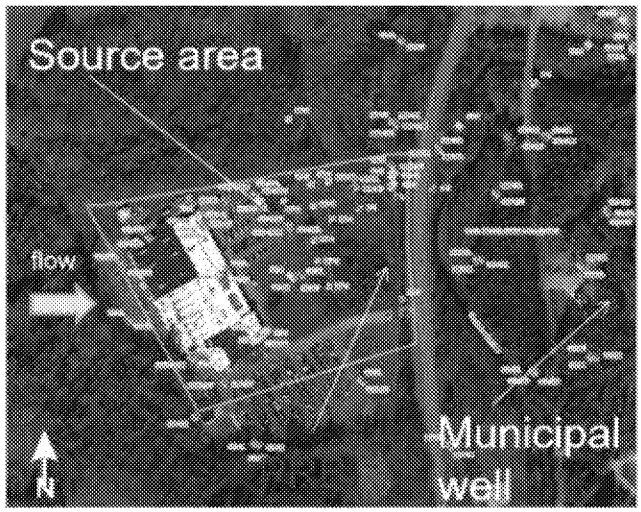
Partners: New Hampshire Department of Environmental Services (NHDES)
Challenge: Suitable groundwater remediation technologies at the South Municipal Supply Well Superfund Site (ongoing)
Resource: Technology transfer and technical support for permeable reactive barrier & thermal remediation



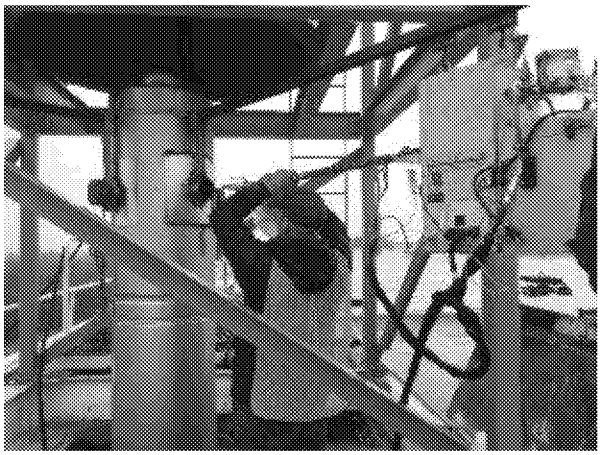
"EPA ORD personnel have provided invaluable technical support to the South Municipal Well government team."
– NHDES Waste Management Division Kenneth Richards

The South Municipal Water Supply Well Superfund Site located in Peterborough, New Hampshire, includes the New Hampshire Ball Bearings (NHBB) property, adjacent wetlands, commercial/residential properties, and the South Municipal Water Supply Well. Installed in 1952, the South Well provided water to Peterborough for nearly 30 years. In 1982, concentrations of volatile organic compounds were detected in the South Well at levels above 100 parts per billion and use of the well discontinued. Initial groundwater and soil cleanup actions at the site included in-situ vacuum extraction and groundwater pump-and-treat using air stripping and carbon adsorption. In 2010, revised groundwater remedies were initiated to include a combination of two treatment technologies: 1) thermal remediation within targeted source areas, and 2) in-situ groundwater treatment using a zero-valent iron permeable reactive barrier (PRB).

NHDES and EPA Region 1 (New England) first requested EPA ORD technical assistance in 2009 for information on innovative remediation technologies, including thermal, enhanced bioremediation, and PRB applications. Technology transfer efforts by ORD personnel resulted in recommendations on bench-scale studies, site characterization and monitoring requirements, and final implementation of the thermal and PRB remedies. In 2014, the PRB was installed along the alignment of the former Boston & Maine Railroad (B&M) line to intercept and treat groundwater contaminants emanating from the eastern NHBB property line. Thermal remediation using Electrical Resistance Heating technology was completed in 2016. Approximately 5,000 pounds of tetrachloroethylene (PCE) were removed from the subsurface. ORD personnel continued to provide technical assistance to the NHDES and EPA Region 1 teams by helping to determine the effectiveness of the thermal and PRB remedies.

Recent groundwater data collected from the site show that the PRB is failing to meet specified treatment criteria. Current technical transfer efforts being provided include: assistance in interpreting site data; recommendations on study designs for characterizing groundwater and solid-phase properties; and analytical support to help diagnose the cause of the unanticipated inadequate treatment performance.

Partners: New Hampshire Department of Environmental Services (NHDES)
Challenge: Understanding what perfluorochemicals (PFAS) are being emitted from industrial sources (ongoing)
Resource: Application of non-targeted high-resolution mass spectrometric methods to environmental characterization; air/stack sampling methods development and testing



"EPA ORD's application of non-targeted high-resolution mass spectrometric methods to detect current PFAS emissions in air, water and soils has been a tremendous assist to NH as we assess emissions from current operations and treatment technologies to stop air emissions." – NHDES Assistant Commissioner Clark Freise

Following the emergence of concerns about long-chain per- and polyfluoroalkyl substances (PFAS), the state of New Hampshire has conducted extensive work characterizing "legacy" PFAS, primarily using contract laboratories. However, there are ongoing technical challenges in this work, including: limitations in current analytical methods to comprehensively assess PFAS environmental contamination and related fate and transport expertise, handling more complex sample matrices, and the unknown nature of compounds. Regional, state, and contract laboratories are able to evaluate a relatively narrow slice of legacy PFAS, leaving environmental degradates and new generation PFAS invisible.

There are known industrial sources of PFAS along the Merrimack River. To evaluate the environmental and public health impact, NHDES requested EPA ORD's assistance to help them assess emissions and contamination comprehensively. Of particular interest is conducting novel analyses to reveal the possible presence of newer fluoropolymer materials. This has led to a strong collaborative effort with EPA Region 1 (New England) and NH collecting valuable samples and ORD applying novel methods of sampling (air) and analysis (non-targeted high-resolution mass spectrometry). Samples of water and soil had previously been collected to help understand the entirety of contamination that may have resulted from the operation of the plant. The collaborative effort has allowed an opportunity to engage in research to test new monitoring methods and instruments with the end goal of a comprehensive assessment of environmental contamination of per- and polyfluorinated materials.

As a result, a first report based on targeted analyses was delivered in April 2018. Sampling and analysis is ongoing, as well as employing non-targeted analysis techniques to identify novel PFAS. This work will help NH better understand the extent of contamination, and determine the needs for and proper design of air pollution control equipment to control PFAS emissions.

NEW JERSEY

Partner: New Jersey Department of Environmental Protection (DEP)
Challenge: PFAS contamination (ongoing)
Resource: Water, soil and sediment analyses

"EPA ORD's studies have provided critical information needed to develop PFAS human health risk assessments. In particular, we appreciate your foresight in initiating studies of PFNA several years before it was widely recognized as a potential concern. Also, we especially thank you for your ongoing willingness to share your knowledge of PFCs (perfluorinated compounds) in general, to answer all of our questions about your studies, and to continue working with us on identifying PFAS sources." – New Jersey DEP Research and Environmental Health, Division of Science, Gloria B. Post, PhD, DABT

A concern of New Jersey DEP is the ongoing presence of poly- and perfluoroalkyl substances (PFAS) in the drinking water resources of southwestern New Jersey. New Jersey DEP reached out to EPA ORD when they were faced with relatively high contaminant levels of a specific PFAS (perfluorononanoic acid, PFNA). New Jersey DEP continues to study the potential routes PFAS might be following in finding its way into these water resources. The chief questions are where the contamination is originating and whether it is getting into the water through direct discharge or through the air. Previous analysis of water samples suggests that by looking at the ratios of different PFAS, it might be possible to identify a source signature that could help determine the contaminant's origin. The goals of this study are to confirm that PFAS contamination is occurring, establish specific PFAS source signatures, and evaluate the potential for impacts due to air deposition.

New Jersey DEP has requested that ORD continue to work with them to analyze water, sediment and soil samples for PFAS and their byproducts. In addition, ORD will collaborate with New Jersey DEP to evaluate the data and summarize the study's findings in a joint publication.

NEW YORK

Partner: New York City (NYC) Department of Health and Mental Hygiene (DOHMH) and NYC Transit
Challenge: The ability to effectively conduct sampling operations following a large biological incident within a highly urbanized area in the U.S. (ongoing)
Resource: Technical assistance to evaluate the compatibility of current surface sampling options and analytical methods for *Bacillus anthracis*

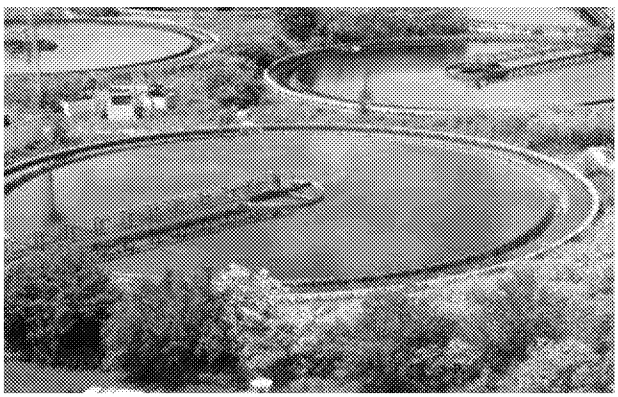
"The instant that a biological threat agent incident has been detected, incident commanders will depend on and expect accurate and reliable incident characterization to support informed public health decision making. EPA's groundbreaking efforts in this regard will prove critical to New York City's ability to determine the scale and scope of biological incidents rapidly and efficiently." – NYC DOHMH Bioterrorism Surveillance Coordinator Joel Ackelsberg, MD, MPH

EPA researchers have worked collaboratively with NYC DOHMH and NYC Transit to answer key gaps in capabilities to conduct effective sampling operations following a large biological incident within a highly urbanized area. EPA researchers, in collaboration with these partners, evaluated the compatibility of current surface sampling options, when applied to urbanized outdoor or underground (subway) surfaces, with current analytical methods for *Bacillus anthracis*. EPA researchers and NYC DOHMHC have also worked collaboratively to determine the potential utility of "Native Air Sampling" approaches, and their compatibility with analysis methods.

Because of this federal-local partnership, NYC personnel actively participate in project update teleconference meetings and provide critical input into the project's directions. In this way, NYC has access to research outcomes as they develop, and NYC has ensured that the project meets the city's emergency response needs. Ultimately, the project has resulted in an enhanced ability to conduct sampling and analysis operations for a large urban area following a *Bacillus anthracis* contamination incident.

NORTH CAROLINA

Partners: NC Department of Environmental Quality, City of Charlotte, City of Raleigh
Challenge: Acceptance of bio-contaminated wastewater by Publicly Owned Treatment Works (POTWs)
Resource: Technical support in the area of pathogens in wastewater infrastructure



"The question of how wastewater plants deal with bio-contaminated waste needs to be addressed before a potential health emergency surfaces. EPA's proactive work to assist wastewater operators before the next emergency occurs is not only prudent, but critical in order to protect public health." – NC DEQ Assistant Secretary Sheila Holman

In October 2014, EPA held a forum on pathogens in wastewater infrastructure for state and POTW representatives. The forum focused on providing recommendations, technical information and potential solutions to the wastewater industry, particularly for emergencies.

EPA is investigating data needs that, if filled, would assist wastewater plant operators in making decisions about whether and how to accept wastewater contaminated with pathogens (e.g. anthrax bacteria, Ebola virus) during an emergency. EPA is also in the process of performing research projects to address needs associated with POTW acceptance of wastewater potentially contaminated with pathogens.

The forum was organized around the following questions: How do we deal with wastewater contaminated with biological agents such as *Bacillus anthracis* or Ebola virus? What is needed/required for utilities to accept bio-contaminated wastewaters? What sorts of tests, protocols and regulatory guidance are needed? What is needed for permit authorities in NC to guide/allow utilities to accept these wastes? How should these (tests, protocols and regulatory guidance) be designed or implemented? Who should design and evaluate these? Are there other "simpler" tests and protocols? What is needed to address concerns and issues raised by the public, wastewater workers and operators? What are the data gaps and what type of research is needed?

As a result of this forum, EPA and the Water Environment Research Foundation held a national workshop on this topic in 2016. In turn, this led to several research projects being planned and implemented to address the key research gaps and needs brought up in the workshop.

Partners: NC Department of Environmental Quality (DEQ), Cape Fear Public Utility Authority, Town of Pittsboro, Fayetteville, NC State Highway and Public Works Commission
Challenge: Mapping PFAS levels across an entire river basin
Resource: Methods development and laboratory analyses

"We are extremely grateful for EPA ORD's work as we analyze these chemical compounds. EPA's analyses will be crucial to our efforts in protecting public health and the environment as we learn more about these emerging substances." – NC DEQ Assistant Secretary Sheila Holman

Because of concerns about long-chain per- and polyfluoroalkyl substances (PFAS), which persist in the environment, their use began being phased out in 2006. In 2007, EPA ORD began a first-ever effort in the U.S. to map PFAS levels in an entire watershed, focusing on North Carolina's Cape Fear River Basin. This mapping effort demonstrated that there were multiple sources of many different PFAS throughout the basin, suggesting that since the basin is a major drinking water resource, it could potentially be responsible for human exposures to PFAS throughout the entire region. As part of this effort, EPA ORD also developed research based methods to measure PFAS in drinking water, and detect novel PFAS using high resolution mass spectrometry non-targeted analysis approaches.

EPA ORD's PFAS research in the Cape Fear Basin has continued to evolve. Having largely addressed PFAS waste water discharge to the Cape Fear River, attention has turned toward air emissions, fate, transport, deposition, and resulting land and surface water contamination down wind of the Chemours plant. EPA ORD is working with Region 4 and NC DEQ to test and deploy air sampling methods including the application of non-targeted analysis to comprehensively characterize air emissions. NC DEQ is also sampling and making available rain water for testing. This work is being done cooperatively with Chemours to evaluate air emissions control technology that they are considering. These efforts are expected to provide solutions for reducing exposures to these potentially hazardous chemicals.

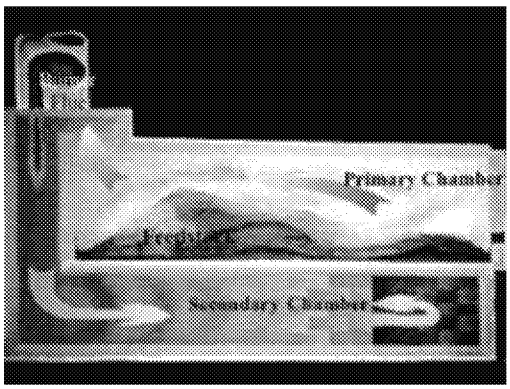
Partners: US2020, Citizen Schools, Durham Public Schools, WakeEd Partnership, NC Science Mathematics and Technology Education Center, NC Science Festival, East Durham Children's Initiative, North Carolina State University Kenan Fellows Program for Teacher Leadership
Challenge: Preparing the future environmental health workforce by providing STEM (science, technology, engineering and math) education, especially in K-12 schools with low-income populations (ongoing)
Resource: EPA's Community Engagement and STEM Education Program in RTP

"EPA's Community Engagement and STEM Education Program in RTP has not only has been a source of ideas for our own outreach program improvement but also serves as a model STEM outreach organization in the region, because of its impactful work in schools, museums, and on-site for students of all ages through speed mentoring, job shadowing, and hands-on STEM activities." – The Research Triangle Foundation, STEM in the Park Outreach Program Manager Sarah Council Windsor

EPA's Community Engagement and STEM Education Program in RTP provides guest speakers and judges at science competitions, engages in impactful community partnerships, and provides hands-on educational programming for students and teachers in central NC and beyond. Most of the programming takes place in schools where at least 50 percent of students are on free or reduced lunch. The partners strive to inspire all students to consider STEM careers with the understanding that a diverse workforce is essential in addressing future environmental challenges.

EPA ORD develops hands-on activities and interactive discussions to engage student STEM learning and promote environmental awareness. Through participation in local, state and national education conferences, the partnership offers K-12 educator trainings that provide teachers with hands-on STEM strategies for their classrooms and shares the partnership model with other agencies and businesses. Additionally, EPA RTP's campus hosts many educational events each year, including a week-long science workshop for high school students. EPA RTP was awarded two US2020 STEM Mentoring Awards in 2017 – one for Excellence in Volunteer Experience, and a second for Volunteer Mobilization. The Excellence in Volunteer Experience Award recognizes STEM programs that provide high-quality, well-supported STEM activities for their volunteers, while the Volunteer Mobilization Award honors organizations that effectively engage their workforce to support youth-serving organizations.

Partners: North Carolina Department of Agriculture and Consumer Services (NCDA&CS)
Challenge: Disposal of contaminated animal carcasses following an agricultural emergency (completed)
Resource: A prototype transportable gasifier technology for on-farm disposal of animal carcasses



"EPA has served as the coordination point for both the research and the response efforts related to mass disposal. Actual event response and field testing identify real problems that cannot be properly identified or solved when designing or modeling in an office. Environment, material handling, human factors, size and volumes of actual events must be experienced not perceived. EPA understands these challenges and continues to assist states and industry in attempting to solve the problems and bring workable technologies. Continued research and development efforts of this type are critical to assisting industry in their efforts to protect the food chain." – NCDA&CS Jim Howard (retired)

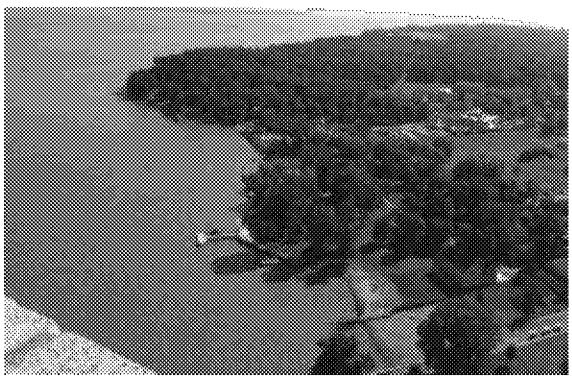
Agricultural emergencies, such as foreign animal disease outbreaks, could result in the need to dispose of many contaminated animal carcasses. The environmental impacts of carcass disposal are site-specific. Some technologies (e.g., burial) are not viable in areas with a high water table, such as North Carolina. Multiple disposal options are necessary. Gasification has the potential to be a technology for on-farm use, which reduces risk associated with transporting the carcasses to an off-site location (e.g., landfill, incinerator). It also has the potential to generate energy at agricultural sites during non-emergency times, and burns more cleanly thus requiring less pollution control equipment than conventional incineration.

As part of an interagency effort involving several federal agencies and the state of North Carolina, EPA built a prototype transportable gasifier intended to process 25 tons per day of carcasses (scalable to 200 tons per day) for on-farm disposal of animal carcasses. A demonstration was conducted to determine the feasibility of gasification for carcass disposal and to identify technical challenges and improvements to simplify and improve the gasifier as a mobile response tool. Past testing of the prototype demonstrated partial success, in that the transportability and rapid deployment requirements were met; however, the throughput of animal carcasses was approximately one-third of the intended capacity.

Significant modifications were made to various gasifier components, including the burner system, feed system, control system, power distribution and ash handling system, in order to increase its operating capacity to the rated design throughput. In September 2015, a series of tests were performed to evaluate the effectiveness of the design modifications at increasing the system's throughput, as well as to demonstrate the unit's ability to operate around the clock for an extended period of time. While the ash removal system and the system to move material across the bed failed during the tests, the new
burner, feed, control and power distribution systems all functioned in an acceptable manner. The test and evaluation showed that improved alloys would be needed in some of the parts to achieve the desired results. EPA ORD's support has helped the NCDA&CS focus on which areas of the system require repair and additional modifications to achieve overall design goals.

OHIO

Partners: Ohio Environmental Protection Agency (EPA) and public water utilities along Lake Erie
Challenge: Managing algal toxins in drinking water treatment plants (ongoing)
Resource: Algal toxin and water quality studies at drinking water treatment plants using Lake Erie as their source

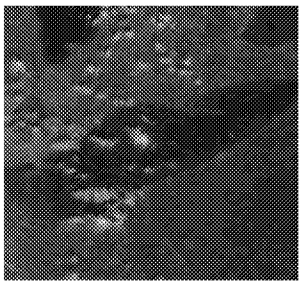


"Ohio and EPA ORD continue to lead the nation in working with public water systems to ensure safe drinking water and minimize the threat of harmful algal blooms (HABs) and other emerging contaminants. Research that EPA ORD is doing is providing Ohio with immediate and practical information as we implement first in the nation rules on HABs, and we are grateful and fortunate and thankful for the collaboration on these important issues." – Ohio EPA Director Craig Butler

Increasingly, drinking water treatment plants are challenged by changes in the quality of their source waters and their aging treatment and distribution system infrastructure. Individually or in combination, factors such as decreasing water and financial resources, climate change, agricultural runoff, harmful algal blooms and landscape development increase the probability that algal toxins, pesticides, pharmaceuticals, personal care products, endocrine disrupting compounds and other contaminants of emerging concern will remain after treatment, ending up in people's drinking water.

In cooperation with public water utilities along Lake Erie, EPA ORD and Office of Water are conducting studies to improve our understanding of the propagation of contaminants of emerging concern (particularly cyanotoxins) through the drinking water treatment process, and to identify the best approaches for removing them. The recent sampling campaign provided a unique opportunity to characterize the development of Lake Erie's cyanobacterial bloom and its associated toxins at a high level of analytical detail. Researchers were able to provide utilities and regulators with treatment recommendations that will help them make better informed long-term decisions regarding the operation and modification of treatment processes to optimize removals.

Partner: Ohio Environmental Protection Agency (EPA) and the City of Toledo
Challenge: Harmful algal bloom preventing access to drinking water (completed)
Resource: Innovative drinking water testing to help restore drinking water availability



"When we were faced with an emergency in Toledo, August 2017, due to cyanobacterial toxins detected in their treated drinking water, EPA ORD staff was a great partner and exceeded our expectations in understanding science and helping optimize treatment and restore safe drinking water to our residents." — Ohio EPA Director Craig Butler

On August 2, 2014, the Mayor of Toledo, Ohio, issued a "Do Not Drink" order for the 500,000 people of the City of Toledo and neighboring communities because the water utility detected cyanobacterial toxins in their treated drinking water. The City's drinking water source, Lake Erie, was experiencing a large cyanobacterial harmful algal bloom at the time. Cyanobacteria, also known as blue-green algae, is particularly tricky because toxins are released from the bacteria when they are damaged, so boiling the water only makes the situation worse. The water ban set in motion a number of emergency actions, including Ohio Governor John Kasich declaring an emergency in the area, the mobilization of the Ohio National Guard to distribute bottled water, and the closure of hundreds of water dependent businesses in the Toledo metro area.

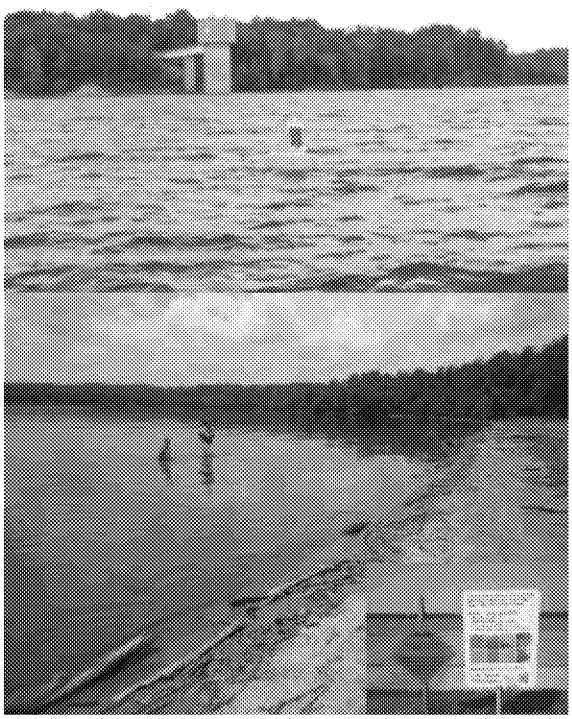
Working in conjunction with the City of Toledo, Ohio EPA officials immediately reached out to EPA ORD's Cincinnati-based research laboratory for technical assistance. This laboratory is known as a world leader in the evaluation and development of innovative drinking water testing, monitoring, and treatment technologies. Ohio EPA asked for assistance with laboratory analyses for the presence of cyanobacterial toxins in treated drinking water, and identifying the optimal approach for controlling cyanobacterial toxins in the drinking water treatment plant and distribution system. EPA ORD assembled a team of scientists and engineers to work throughout the weekend. The ORD team led discussions regarding sample handling and procedures and facilitated an agreement between Ohio EPA and the City of Toledo as to how they would collect and handle samples. Samples were handled per the protocol, and chemical analyses were run by an agreed upon procedure between Ohio EPA, the City of Toledo and EPA. Following the initial set of samples, the City of Toledo collected additional water samples throughout their treatment plant to assess the effectiveness of various treatment processes in reducing the cyanotoxin concentrations. The ORD team assessed sample results as the analyses were completed, and discussed what the results indicated about their current treatment processes with Ohio EPA and Toledo's Department of Public Works. ORD scientists recommended treatment plant adjustments to further reduce cyanotoxin levels in the finished drinking water, and communicated the issues to local and state officials in real time during the event.

ORD's efforts to produce timely and accurate results were critical for the Mayor of Toledo and the Governor of Ohio when making their decision to lift the "Do Not Drink" order two days later on August 4, restoring safe drinking water to some half a million people. Soon after the order was lifted, EPA's Office of Water consulted with the ORD team and Ohio EPA to identify the lessons learned from the Toledo incident, particularly with regard to the sample preservation and handling procedures for cyanotoxin samples, identifying areas where improved guidance could be provided to U.S. drinking water systems performing cyanotoxin monitoring to assure samples are appropriately preserved for transport and prepared for analysis. Ohio has long enjoyed a strong relationship with ORD.

Partner: Clermont and Brown County Soil & Water Conservation Districts, Clermont County Office of Environmental Quality, Clermont County Water Division, Ohio EPA, Ohio Department of Agriculture/National Resources Conservation Service

Challenge: Managing excessive nutrient runoff into East Fork Lake (Lake Harsha), which is causing harmful algal blooms (ongoing)

Resource: The East Fork Watershed Cooperative is a collaboration between local, state and federal entities including the U.S. Army Corp of Engineers (USACE) and the U.S. Geological Survey (USGS) responsible for assessing and managing water resources



"This partnership has made a huge difference in what we've been able to do at the local level. The research and expertise involved in the Cooperative has made things possible that we would never have been able to do on our own." — Clermont County Soil and Water District Administrator John McManus

Excessive nutrient runoff in East Fork Lake causes harmful algal blooms (HABs). These HABs in turn can produce cyanotoxins, which are harmful to human health, and can compromise drinking water safety. EPA ORD along with several federal, state and local agencies collaborated to form the East Fork Watershed Cooperative to address this issue.

This multiagency cooperative, led by EPA ORD staff, leverages resources to help demonstrate how to better protect water quality in the watershed. EPA provides technical support and guidance, runs watershed simulation models, provides expert review, assists USACE in monitoring water quality, participates in state-wide HAB modeling efforts with USGS, and supports the state of Ohio on nutrient Total Maximum Daily Load (TMDL) implementation in the East Fork.

The short-term goal of the cooperative Is to provide early warning and efficient treatment plans for the toxic algae problem in Lake Harsha. Their long-term goal is to eliminate the algae problem by reducing runoff from nonpoint sources.

OKLAHOMA

Partner: Oklahoma Department of Environmental Quality (DEQ)
Challenge: Fish kills and unknown contamination (completed)
Resource: Chemical composition analysis

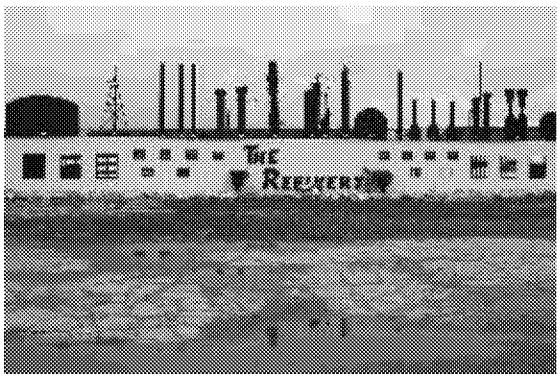
"The ORD National Exposure Research Laboratory in Las Vegas was a valuable asset during Oklahoma DEQ's investigation into the Red River fish kills. This facility's expertise and analytical technologies assisted with researching potential causative agents related to these fish kills. In addition, I strongly support the mission of ORD to conduct valuable research that leads to improvements in the continued protection of public health and the environment." — Oklahoma DEQ Executive Director Scott Thompson

Between 2011 and 2013 there were several incidents of concern in the Red River watershed and Red Creek. There were four fish kills with unknown contaminants present in the water, and stray gas bubbling between fish kill events. Oklahoma DEQ requested EPA ORD assistance in identifying the unknown contaminants, and the source of the indeterminate stray gas.

EPA ORD scientists, in collaboration with Region 6 (South Central U.S.) set out to use state-of-the-art analytical tools to identify the contaminants, and to oversee an isotopic analysis of the gases sampled by a private company.

Through these techniques, ORD was able to make conditional chemical assignments of the contaminants and help determine that the stray gases were from a biogenic (natural) source. This assistance provided information to Oklahoma DEQ to assist in understanding and managing these incidents.

Partners: Oklahoma Department of Environmental Quality (DEQ)
Challenge: Evaluation of groundwater and surface water interactions at the Oklahoma Refining Co. Superfund site (completed)
Resource: Technical evaluation of remediation plans for the site



"EPA ORD provided concrete recommendations on data acquisition that have been incorporated into the ongoing investigation at the refinery. This access to experts really augments our ability to focus our resources to obtain the right information to support decision making." – Oklahoma DEQ Executive Director Scott Thompson

The Oklahoma Refining Co. Superfund site is located in Cyril, Oklahoma. Gladys Creek adjoins the site along its northern and eastern borders. The 160-acre abandoned site, which was operated by several different owners as a refinery until 1984, had generated wastes in approximately 50 impoundments (many unlined) and several buried waste areas. Shallow groundwater beneath the site flows away from the Cyril community and discharges into Gladys Creek. Approximately 1,600 people on public or private drinking water wells live within three miles of the site, with the closest well (private) within 1000 feet of the site.

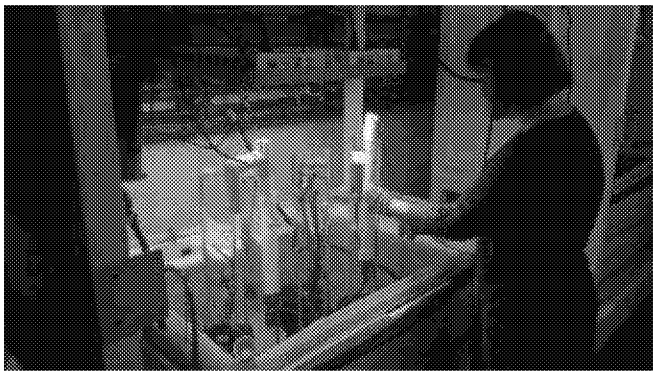
Site operations contaminated soil, sediment, surface water and groundwater with polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs) and metals. Wastes had been placed in surface pits on the refinery property, and wastewater had been sent through an oil-water separator to remove oils and then treated in a series of surface impoundments. Treated water from the surface impoundments was discharged into Gladys Creek.

Cleanup of impoundments and waste sources was conducted between 1996 and 2001 on the southern portion of the site; most removal activities were completed in 2006 on the northern site. The remaining work, including the piece that EPA ORD helped with, includes groundwater, surface water, north side soil, and sediments.

Previous site investigations provided extensive information on contaminant concentrations in groundwater, surface water, soil and sediments. This information has indicated where contaminants are found and where they exceed the relevant standards. However, an estimation of the mass flux of contaminants in either groundwater or surface water is necessary to determine the magnitude, rate and significance of adverse impacts on Gladys Creek and to evaluate what actions need to be taken regarding those impacts. The strategy to conduct this effort consists of identifying all major routes of groundwater discharge into Gladys Creek, quantifying groundwater and surface water discharge, estimating the contaminant mass flux in the surface water and groundwater, and evaluating the overall hydrology of the Gladys Creek watershed. ORD has provided technical review comments to the state and EPA Region 6 (South Central U.S.) for the *Plan Development to Evaluate the Impacts of the Ground-Water/Surface Water Interactions on Contaminant Migration at the Oklahoma Refining Company Superfund Site, Cyril, Oklahoma.* It is anticipated that this information provided by ORD researchers will assist Oklahoma DEQ in developing a remedial design for the remainder of the site.

OREGON

Partner: Oregon Department of Fish and Wildlife (DFW)
Challenge: Acidification in estuaries harming clam and crab fisheries (ongoing)
Resource: Ocean acidification research

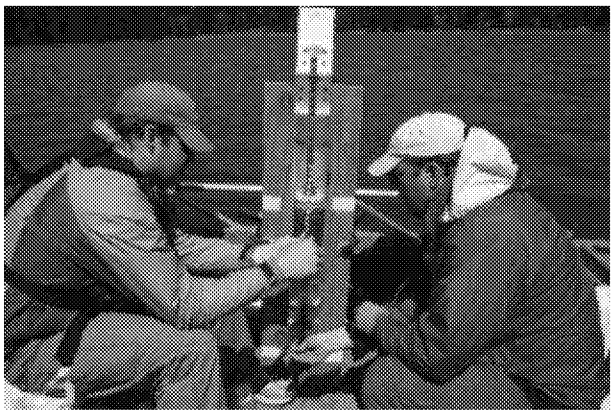


"The expertise of the scientists at the Newport US EPA lab has been valuable as we evaluate how to improve monitoring of ocean acidification-related parameters and the value of seagrasses in buffering the effects of ocean acidification. Oregon's shellfish aquaculture industry – and likely our wild marine species – are at risk from current ocean conditions, which are projected to become more corrosive over the next several decades." – Oregon DFW, Marine Resources Program Manager Caren Braby

Increasing acidification of offshore ocean waters has harmed the oyster aquaculture industry in Oregon and threatens the state's recreational and commercial fisheries for bay clams and Dungeness crabs. Governors of California, Oregon and Washington have joined with stakeholders through the Pacific Coast Collaborative to develop coordinated solutions to address the adverse effects of ocean acidification. In Oregon, the Oregon Coast Ocean Acidification and Hypoxia Workgroup formed to advance recommendations from the Collaborative. This workgroup, led by the Oregon DFW, includes representatives from Oregon Department of Environmental Quality, Oregon Department of Agriculture, EPA ORD, Lower Columbia River Estuary Partnership, Tillamook Estuaries Partnership, several tribes and watershed councils, the oyster aquaculture industry and universities.

In addition to participating in the interagency workgroup, ORD scientists are conducting research on the contribution of excess nutrients to acidification of estuarine waters, methods to distinguish human from natural sources of nutrients in estuaries, and the use of seagrass meadows as a method to reduce the effects of acidification to shellfish. The research is being conducted at ORD's Pacific Coastal Ecology Laboratory in Newport and in Tillamook Bay – site of Oregon's largest inshore shellfisheries. The results of this research will provide state agencies with tools to reduce the causes and effects of acidification in Pacific Northwest estuaries, thereby enhancing the environment and economies that depend on the shellfisheries.

Partners: Oregon Department of Environmental Quality (DEQ)
Challenge: Determine the influence of water level fluctuations on the seasonal production of methyl mercury in the Cottage Grove Reservoir (completed, but continued interactions)
Resources: Technical Investigation to help reduce methyl mercury levels



"I think this is valuable information for understanding potential methyl mercury loading contributions and methylation mechanisms related to water level fluctuations in Cottage Grove Reservoir. Looking ahead, this study suggests some potential considerations related to reservoir flow management that could help mitigate mercury methylation potential." – Oregon DEQ, Water Quality Monitoring Manager Aaron Borisenko

The Cottage Grove Reservoir located south of the Historic Black Butte Superfund Site has received historical and ongoing loading of mercury and transport of contaminated mercury sediments resulting in strict fish consumption advisories. Cottage Grove Reservoir operates as a flood control reservoir, and lower water levels during the fall and winter expose 60-80 percent of the reservoir sediments.

EPA ORD researchers designed an investigation at Cottage Grove to determine whether the seasonal exposure of reservoir sediments was contributing to the elevated level of methyl mercury within the reservoir water column. Results from the investigation identified that the seasonal lowering of the water level corresponded with increased production of methyl mercury in sediments that were exposed to the atmosphere. Currently, discussions for altering reservoir management strategies to control seasonal production of methyl mercury are underway. By lowering the loading of mercury to the reservoir, Oregon DEQ hopes to benefit communities that catch and eat fish.

Partner: Multnomah County, OR
Challenge: Help communities identify local environmental issues (completed)
Resource: EPA's Community-Focused Exposure and Risk Screening Tool (C-FERST) and technical support

"Environmental consultants and business owners have the means to conduct environmental assessments but communities often don't. C-FERST changes that paradigm by making information about Brownfields (former commercial or industrial sites) accessible, thus placing decision making back into the hands of communities. It allows them to leverage resources that turn sites like Brownfields into something good for the community. What is powerful about C-FERST is that it advances EPA's responsibility to the public by taking public record and technical EPA documents and making them accessible for communities." – Multnomah County's Senior Program Specialist Matthew Hoffman

EPA's Community-Focused Exposure and Risk Screening Tool (C-FERST) is an online tool that helps communities identify environmental issues around them, learn about these issues, and then explore ways to reduce their health risks.

Officials from Multnomah County and the nonprofit organization, Groundwork Portland, used C-FERST to identify brownfields in their area and determine possible uses for these properties. The partners used C-FERST to conduct a community livability study assessing transit accessibility, food retail resources, and other issues as part of a neighborhood redevelopment plan in the county.

Students from Concordia University used C-FERST to conduct a children's health and wellness study in Portland. Students used the tool's community data to identify potential sources of social and environmental stress, including exposure to diesel pollution, poverty and access to medical care. Recommendations from their assessment were presented to community and government representatives.

EPA has decided to discontinue C-FERST as a stand-alone tool and instead move to a single GIS-based platform containing both ecological and human health data. EPA expects that the current site will remain in place through the end of FY18 and will make certain that information about how to access maps, functionality, and datasets transferred to other tools is made available to interested parties.

Partners: Oregon Department of Environmental Quality (DEQ); Oregon Department of Agriculture
Challenge: Improve surface and groundwater nitrate contamination from agriculture (completed)
Resource: Collaborating with farmers to assess the effectiveness of fertilizer best management practices

"EPA ORD scientists have made significant contributions to the monitoring program in the southern Willamette Valley Groundwater Management Area. Their technical expertise has enhanced analyses of complex hydrological systems, as well as informed Oregon DEQ synthesis of multi-scale factors impacting nitrate concentrations in the southern Willamette Valley." – Oregon DEQ Joni Hammond (former acting director)

Groundwater nitrate contamination affects thousands of households in the Southern Willamette Valley Groundwater Management Area in Oregon. To reduce non-point source loading of nitrogen to groundwater and surface water, successful approaches are needed within affected communities to integrate science, outreach and management efforts. A partnership was formed that brings together commercial farmers, Oregon Department of Agriculture, soil and water conservation districts and EPA to assess the current state of groundwater in the Valley, and to evaluate best management practices (BMPs) in fertilizer management.

In this collaborative project, scientists measured nitrate leaching from 15 fields in the Valley. They shared the data with farmers and discussed BMPs for fertilizer application that would reduce the leaching. Farmers have instituted some of these BMPs on their fields, and are now seeing positive results for nutrient use efficiency and less contamination.

In addition, EPA ORD scientists have provided stable isotopic analyses to identify the causes of high temporal nutrient variability within local wells. These efforts have helped illuminate complex groundwater-surface water interactions and greatly improved Oregon DEQ's monitoring program for the groundwater management area. ORD efforts helped to reduce potential new inputs of nitrate into the groundwater system and understand the complex dynamics of groundwater in general.

Partner: Oregon Department of Agriculture (ODA)
Challenge: Managing Oregon's commercial shellfish harvests to reduce public health risk (ongoing)
Resource: Improved methods to forecast environmental conditions that lead to shellfish harvesting closures

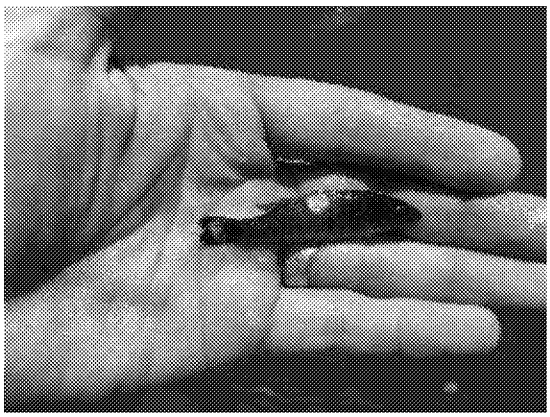
"Tillamook Bay is one of the most productive and diverse commercial shellfish growing bays in Oregon. Environmental characteristics and human development in the watershed also make it one of the most complicated in terms of pollution impacts. The work EPA is doing on fecal indicator bacteria will provide valuable information on sources of water pollution at a level that has not been possible before. This information will be used to ensure safe food can continue to be produced from this bay and help maintain the livelihoods it supports." — ODA Food Safety and Animal Health Program, Food Safety Inspector & Shellfish Specialist Alex Manderson

To protect human health, state agencies close estuarine waters to shellfish harvest during periods of elevated fecal bacteria and other factors. In Tillamook Bay, Oregon, elevated bacteria levels result in shellfish harvest closures approximately 100 days a year, affecting the State's largest concentration of commercial wild-caught shellfish and oyster aquaculture operations. ODA has authority to restrict the harvesting and distribution of shellfish by commercial processors if there is potential risk for illness to consumers. ODA bases harvest closure decisions on river flow and precipitation, which works well during wet seasons when runoff may carry fecal bacteria from urban or agricultural sources into shellfish growing areas. However, these environmental variables do not predict elevated fecal bacteria levels well during dry, summer months during peak shellfish harvesting season. Season-specific criteria for determining high bacterial loads in the vicinity of shellfish beds would help ODA better ensure the safety of commercial shellfish for the benefit of consumers and the shellfish industry.

EPA scientists are collaborating with ODA shellfish managers to develop improved models to forecast environmental conditions indicative of unsafe levels of fecal bacteria within Tillamook Bay. The research involves statistical analysis of environmental drivers (such as rainfall, wind strength, temperature, river discharge, tide stage) that are associated with changes in the fecal bacteria concentrations at several locations within the estuary, using ODA's bacterial data and publicly available environmental data. The analysis revealed seasonal and locational differences of which environmental drivers had the greatest influence on bacterial levels. Consequently, under a given set of environmental conditions, some parts of the estuary might not require harvest closure, whereas others would. High precipitation and river discharge lead to elevated bacteria levels during wet months (October to May), as expected. During dry seasons (June-September), the research revealed that elevated bacterial levels were associated with strong winds and tidal extremes, and the EPA-developed statistical models performed better than ones currently used by ODA. The models developed by EPA may be used to inform ODA's approach for shellfish harvest closures and improve the effectiveness of future bacterial monitoring efforts.

PENNSYLVANIA

Partner: Pennsylvania Department of Environmental Protection (PA DEP)
Challenge: Wide-spread freshwater fish disease (completed)
Resource: Causal Analysis/Diagnosis Decision Information System (CADDIS)



"I am confident that our science-based partnership with EPA ORD and the Pennsylvania Fish and Boat Commission will help us determine the causes of impacts to aquatic health in the Susquehanna. Science guides our work in assessing the overall health of the river, and in partnership with these agencies, we will be able to create a strategy that matches our challenges to conserve and protect this river, which is important to the recreational vitality and economic prosperity of Pennsylvania." — PA DEP John Quigley (former secretary)

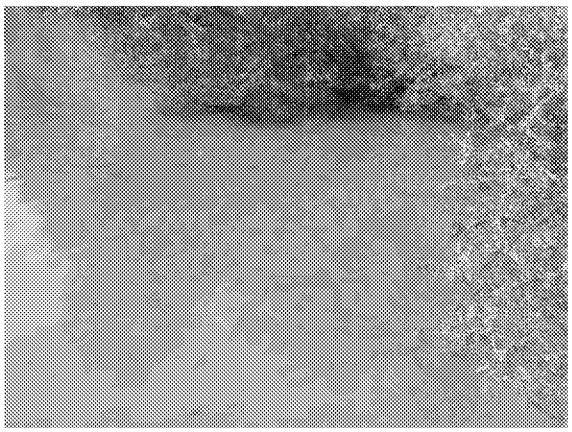
Unusual mortality events and outbreaks of disease have been observed annually in young-of-the-year Smallmouth Bass in the mid to lower Susquehanna River since 2005, resulting in poor recruitment of juvenile fish into the adult population. The Susquehanna River Smallmouth Bass Technical Committee, including representatives from PA DEP and the Pennsylvania Fish and Boat Commission (PFBC), was formed in 2007 to characterize the potential causes of the problems. Numerous water-quality and fish health variables were evaluated, but no definitive associations emerged. Additional research and monitoring efforts continued, and in 2012 PA DEP initiated a large study of the river. In 2014, PA DEP and its partners looked to EPA ORD's expertise and innovative tool, the Causal Analysis/Diagnosis Decision Information System (CADDIS), to help organize and synthesize the data.

EPA assisted PA DEP and its partners in implementing the CADDIS causal assessment process, providing a means to utilize the data collected to date and winnow the long list of hypothesized causes of the poor recruitment of Smallmouth Bass. Candidate causes evaluated included abiotic stressors such as high flows, low dissolved oxygen, high pH, and toxicity from exposure to ammonia or toxic chemicals. Biotic candidate causes included food quality changes from non-native species and cyanobacteria. Diseases caused by pathogens or parasites were considered, as well as the possibility that stressors have increased Smallmouth Bass susceptibility to disease. Over 50 worksheets, comprising 400 pages, that described data collections and analyses were developed and evaluated during the course of assessment.

Pathogens and parasites were identified as likely contributors to the problem: disease prevalence was strongly and negatively correlated with survival of juvenile fish. Endocrine disruptors and herbicides were also judged to be likely contributors by increasing disease susceptibility, although only limited evidence was available to evaluate these candidate causes. The CADDIS process was particularly beneficial for optimizing further data collection and analysis efforts. The financial and personnel resources of the state were redirected to the priorities identified by assessment: endocrine disruptors, parasites and pathogens.

RHODE ISLAND

Partners: Rhode Island Department of Environmental Management (RI DEM), Rhode Island Department of Health, City of Newport
Challenge: Establish target phosphorous and chlorophyll-*a* concentrations necessary to restore and protect the Newport Water Supply Reservoirs (completed)
Resource: Analysis of nutrients and other parameters in water

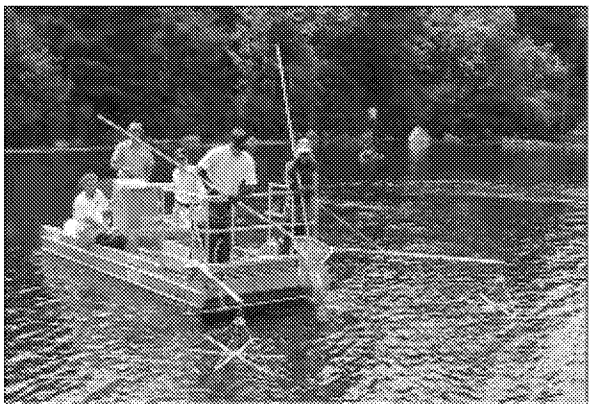


"EPA ORD's contributions to the effort – spanning from its inception to its end – were critical to its success. Of utmost significance was the ORD Atlantic Ecology Division's involvement in securing analytical chemistry support from ORD's Mid-Continent Ecology Division in Duluth, MN, and in performing certain instrumented analyses critical in enabling RI DEM to pursue a comprehensive monitoring program to evaluate relationships between nutrients, algae and cyanobacteria production, total organic carbon and disinfection by-product formation that serve as the foundation for setting TMDL targets for these critical water supply reservoirs." — RI DEM Office of Water Resources Deputy Chief Elizabeth Scott

In 2014, RI DEM identified all nine Newport Water Supply Reservoirs as impaired, citing low water clarity, low levels of dissolved oxygen, frequent algal and cyanobacteria blooms, and elevated levels of total phosphorus, total organic carbon and chlorophyll-*a*. RI DEM added each of the reservoirs to the List of Impaired Waters under the Clean Water Act, and initiated a Total Maximum Daily Load study to address their degraded water quality. The goal of the study was to establish target phosphorus and chlorophyll-*a* concentrations that will ensure algal growth and total organic carbon concentrations are reduced to a level that supports safe drinking water and protects aquatic life as required under the Clean Water Act.

To assist RI DEM, EPA ORD collected water quality monitoring data biweekly from early May through mid-October 2015, from the nine impaired reservoirs located in Newport, Middletown, Portsmouth, Little Compton and Tiverton – all towns in southeastern Rhode Island. RI DEM, in consultation with the Rhode Island Department of Health, will use the analytical chemistry data results to help establish the target total phosphorous and chlorophyll-*a* concentrations necessary to restore and protect the Newport Water Supply Reservoirs.

Partner: Rhode Island Department of Environmental Management (RI DEM)
Challenge: Determining freshwater fishing sites for safe catch consumption and predicting accumulation of mercury (Hg) at untested sites (ongoing)
Resource: Sampling and analysis of mercury from fish tissues sampled across Rhode Island



"EPA ORD has been instrumental in providing technical expertise and analysis of total mercury concentrations in fish from freshwater sites in Rhode Island for over a decade. The data generated are reducing a major data gap and have been used by RI DEM to identify impaired waters under Section 303(d) of the federal Clean Water Act. The data are also reviewed by the RI Department of Health which provides advice to the public about fish consumption and mercury." — RI DEM Office of Water Resources Deputy Chief Sue Kiernan

Mercury (Hg) is a highly toxic contaminant of concern because of its propensity to accumulate in aquatic organisms and to bio-magnify as it moves upward in aquatic food webs to fish. In New England, many lakes, ponds and reservoirs are acidic, unenriched and have conditions conducive to bacterial methylation of Hg. This methylation facilitates movement of mercury into aquatic food webs.

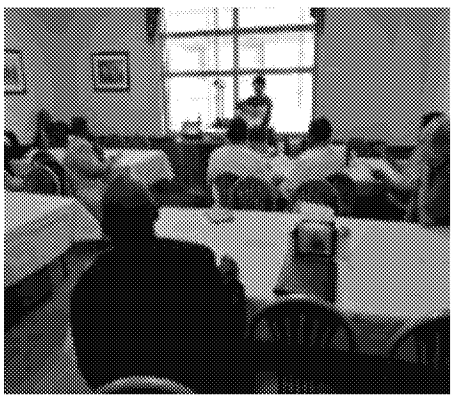
Due to concerns about mercury levels in freshwater fish in Rhode Island, scientists from EPA ORD have been working with scientists in the RI DEM Office of Water and Division of Fish and Wildlife to sample fish and to determine their total Hg concentrations. This 15-year collaboration has resulted in the sampling and analysis of fish communities from more than 50 freshwater sites from locations across the state, including two sites on Narragansett Indian Lands. At more than 75% of sites, mercury concentrations were found to exceed the EPA tissue-based criteria for human consumption in higher trophic level fish, such as Largemouth Bass, Black Crappie and Chain Pickerel. As they are received, the results of fish Hg concentrations are shared with the RI Department of Health, which provides guidance on fish consumption to the public.

This cooperative research effort has also enabled EPA ORD scientists to measure stable isotopes of nitrogen and carbon on fish collected. These measurements are being used in corollary research to develop models for estimating trophic positions of different organisms in the food web. These models are useful for examining movement of energy and contaminants (including Hg) in aquatic systems.

Overall, this EPA ORD and RI DEM collaboration has helped determine which freshwater sites fishers can target for safe harvests, and has provided data to develop models for predicting movement and accumulation of Hg in untested sites.

SOUTH CAROLINA

Partners: South Carolina Department of Health and Environmental Control (SC DHEC), South Carolina Department of Commerce (Commerce), and the City of Columbia
Challenge: Food waste reduction and landfill diversion (ongoing)
Resource: Food Waste Tracker Technology in collaboration with the U.S. Army (Fort Jackson)



"EPA ORD's proposal of the LeanPath demonstration came at an optimal time for Fort Jackson. In the installation's efforts to meet Net Zero Waste initiatives, we have explored ways to divert solid waste from the landfill via off-site composting and food donations. With the implementation of the Lean Path scales, we are able to collect data that supports these measures. Additionally, there is the opportunity to critically assess our dining operations and identify ways to improve operations and make fiscally-sound decisions. EPA ORD has been very engaging and more than helpful during the demonstration." – U.S. Army Garrison Fort Jackson DPW-Environmental Division, Senior Project Manager Tameria Warren

The U.S. Department of Agriculture estimates that one out of six people struggle with hunger in the United States, yet food waste is the single largest component being sent to landfills and accounted for 21 percent (35.2 million tons) of the nation's waste in 2013. South Carolina alone produced an estimated 607,000 tons of food waste in 2015.

In 2014, researchers with EPA ORD's Net Zero program initiated a partnership with SC DHEC, SC Commerce and the U.S. Army to better manage organic waste in the Columbia, SC region. ORD's Net Zero partnerships work with communities and military installations to develop and apply innovative approaches to reduce energy, landfill waste and water use. Collaborators in this South Carolina partnership included representatives who work on waste management issues from local businesses, municipal officials, non-governmental organizations and the Fort Jackson Army base. The partnership provided opportunities to share ideas and best practices through conferences and face-to-face meetings. EPA also conducted a feasibility study for the partnership that recommended strategies for optimizing recycling, repurposing and recovery of organic materials in the region. Since the partnership was created, South Carolina has launched several educational and food waste diversion campaigns, including the "Don't Waste Food SC" state-wide campaign: (www.scdhec.gov/HomeAndEnvironment/Recycling/FoodWaste/).

As a follow-on activity, in March 2017, EPA provided technical expertise, community outreach and funding to conduct a technology demonstration study using the *Lean Path 360* food waste prevention technology at the Fort Jackson Army base – one of the largest military training installations in the nation. LeanPath is an automated food waste tracking system that helps companies and organizations reduce food waste (www.leanpath.com). The project has resulted in over 5 tons of food being donated to South Carolina food donation and composting programs.

Partners: South Carolina Department of Health and Environmental Control (SC DHEC)
Challenge: Developing and piloting effective strategies to target and treat subsurface chlorinated solvent contamination in zones containing numerous subsurface impediments (completed)
Resource: Pilot study including design, construction and deployment of in-situ chemical oxidation (ISCO) technology in collaboration with the U.S. Marine Corps and the U.S. Navy

"Contaminated groundwater poses significant challenges to states. Development of new and innovative ways to treat it in situ is extraordinarily beneficial. We appreciate the availability of ORD expertise to partner with our state experts on this project, and we look forward to future opportunities to engage in collaborative problem solving work." - SC DHEC Director of Environmental Affairs Myra C. Reece

EPA ORD is collaborating with multiple agencies to produce a pilot-scale demonstration of in-situ chemical oxidation (ISCO) technology at the U.S. Marine Corp Recruit Depot in Parris Island, SC.

Spills and leaks of perchloroethylene (PCE), a colorless liquid widely used in the dry cleaning of fabrics, leaked into sanitary sewers resulting in groundwater contamination that is threatening nearby wetlands. The site is underlain by numerous utilities (high pressure water main, high voltage power line, communication line, sanitary and storm sewers, overhead steam lines) and involves high pedestrian and automobile traffic. Rigorous site characterization was used to develop an accurate site conceptual model using an array of aquifer cores and micro-wells to sample groundwater. Relative to conventional groundwater monitoring, more than 60% of the aquifer requiring ISCO was eliminated due to the development of an accurate conceptual site model.

ORD designed, built and deployed a portable, multi-arm, low cost and efficient oxidant injection system. The injection strategy optimized oxidant delivery and distribution in high priority targeted zones. Rigorous monitoring of PCE and the sodium permanganate oxidant helped to focus subsequent injections and to assure hydraulic control of the oxidant. ISCO has been selected by the partnering team for remediation at the site, and recommendations have been provided for design and deployment of full-scale remediation.

TEXAS

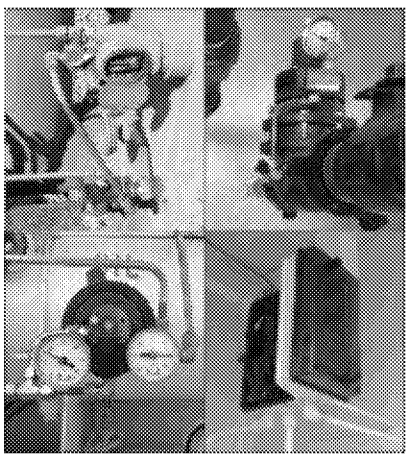
Partner: Texas Commission on Environmental Quality (TCEQ), Texas Department of State Health Services (DSHS) and City of Corpus Christi
Challenge: Chemical contamination in Corpus Christi's water supply (completed)
Resources: Determine health risks and action level

"The water situation in Corpus Christi last December was a good example of cooperation between Texas and EPA and the success we have when all work towards solving an environmental issue." – TCEQ Chairman Bryan W. Shaw, PhD, PE

In December 2016, EPA ORD scientists, in coordination with Region 6 (South Central U.S.), responded to a request for assistance in Texas after an asphalt emulsifying agent, Indulin AA-86, contaminated Corpus Christi's water supply. Toxicity information along with treatment options to remove this chemical from water was lacking. ORD researchers provided assistance early in the response concerning decontamination approaches that might be suitable for use in removing the contaminant from the system. In addition, EPA helped dissect and understand the toxicity of the chemical and possible risks associated with ingestion of contaminated water and the water soluble salt from the product. Texas state agencies, TCEQ and the Texas DSHS, along with ORD researchers and their colleagues across EPA worked together to establish a health-based action level for the contaminant and supported an immediate need to protect public health.

UTAH

Partners: Utah Department of Environmental Quality (DEQ), Oil and Gas Cooperators
Challenge: Support efficient development of U.S. energy resources while protecting human health (ongoing)
Resource: Next generation measurement methods



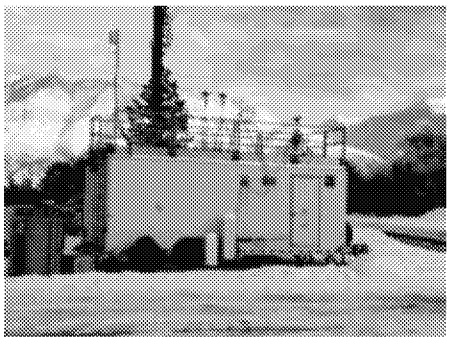
"EPA ORD has been a valuable partner in our efforts to advance needed energy development while improving air quality in the Uinta Basin." — Utah DEQ Executive Director Alan Matheson

Oil and natural gas production has increased significantly within Utah's Uinta Basin and across the United States over the last decade. Approximately three-quarters of the production in the Uinta Basin is on Indian Country within the Uintah and Ouray Reservation. Oil and natural gas extraction and production activities co-emit volatile organic compounds, a subset of which consists of air pollutants that are hazardous to human health, and greenhouse gases directly to the atmosphere.

EPA ORD researchers in collaboration with Region 8 (Mountains and Plains) are working with state officials and oil and gas operators to conduct emissions research on pneumatic controllers used in upstream production for improved process control and safety functions. Because of the very large number of these devices, they contribute significantly to air emissions, however some uncertainty remains regarding the real-world emissions from these devices. In 2016, research was conducted in cooperation with oil and gas operators in the Uinta Basin, Utah on assessing emissions from pneumatic controllers (http://www.scirp.org/Journal/PaperInformation.aspx?PaperID=75669).

The ongoing collaboration between EPA, the state of Utah, and oil and gas operators will improve understanding of these devices and measurement methods, and ultimately support better development of U.S. energy assets in ways that also protect human health and the environment.

Partner: Utah Department of Environmental Quality (DEQ)
Challenge: Fine particle air pollution (completed)
Resource: Ground-based and remote sensing air measurements for the Utah Winter Fine Particulate Study in collaboration with the National Oceanic and Atmospheric Administration (NOAA) and other partners



"The in-kind funding EPA provided, including the sophisticated instrumentation, lab analysis and project management support, was invaluable in making [the 2017 Utah Winter Fine Particulate Study] a success. The nature of fine particle pollution during northern Utah's periodic winter inversions presents a complex scientific problem [which Utah] has been analyzing for many years, and the insight and technical expertise of EPA researchers will certainly help in our efforts to tackle this difficult problem. We are hopeful the measurements and analysis of the complex atmospheric chemical reactions this study captured will enhance our ability to create effective policy tools to improve Utah's air quality during these winter episodes." – Utah DEQ Executive Director Alan Matheson

During the winter in Utah's northern valleys, cold air inversions trap pollution emitted from vehicles, industry and agriculture. This allows atmospheric chemicals to mix and leads to the formation of fine particulate matter ($PM_{2.5}$), which is an air pollutant that is harmful to health when it is concentrated at high levels.

In 2017, EPA ORD provided support to Utah in its Utah Winter Fine Particulate Study – one of the most comprehensive efforts to date to determine the chemical processes in the atmosphere that lead to the formation of $PM_{2.5}$. During January and February, ORD scientists collected ground-based air measurements using new techniques they developed in the lab and remote sensing technology. The data were combined with measurements of the upper atmosphere taken by NOAA using aircraft to obtain a complete analysis of atmospheric chemistry in the valleys.

The science team collaborated on a report that was delivered to the State of Utah in spring 2018 on study findings. Talks are on-going for a future follow on study in Utah. The data from the study will be used by Utah DEQ to develop effective strategies for their State Implementation Plan to reduce $PM_{2.5}$ levels during the winter months. The study will help to improve air quality for the more than two million residents who live in the area.